Golder Associates Ltd.

2390 Argentia Road
Mississauga, Ontario, Canada L5N 5Z7
Telephone: (905) 567-4444
Fax: (905) 567-6561

GEOTECHNICAL STUDY REPORT FOR ENVIRONMENTAL ASSESSMENT YORK RAPID TRANSIT PLAN NORTH YONGE STREET CORRIDOR PUBLIC TRANSIT AND ASSOCIATED ROAD IMPROVEMENTS TRANSIT CLASS ENVIRONMENT ASSESSMENT REGIONAL MUNICIPALITY OF YORK, ONTARIO

Submitted to:

York Consortium 2002
1 West Pearce Street, 6th Floor
Richmond Hill, Ontario
L4B 3K3

DISTRIBUTION

2 Copies - York Consortium 2002, Richmond Hill, Ontario

2 Copies - Golder Associates Ltd., Mississauga, Ontario

July 2008 06-1111-039

TABLE OF CONTENTS

In Order Following Page 17

LIST OF FIGURES

1.0 INTRODUCTION

Golder Associates Ltd. ("Golder") was retained by the York Consortium 2002 (the "Consortium"), on behalf of York Region Transit ("York Transit"), to preliminarily identify geotechnical conditions along proposed transit routes being considered for the development of transit services in The Region of York. The information was requested by the Consortium to assist them in selecting a preferred transit route along the Yonge Street corridor, which is proposed to start at 19th Avenue in Richmond Hill and end at Green Lane in Newmarket. The corridor under consideration extends west of Yonge Street, to Bathurst Street and east of Yonge Street, to Highway 404, as shown on Figure 1.

This report was prepared as part of the requirement for the preparation of the Environmental Assessment that is to be submitted for the North Yonge Street Corridor Public Transit and Associated Road Improvements rapidway route options.

1.1 Rapidway Route Options

The York Rapid Transit Plan has defined several potential transit corridors within York Region to alleviate traffic congestion. This report addresses conditions associated only with the northern Yonge Street corridor (19th Avenue northerly) and its various alignment options.

The proposed rapidway route construction will consist of an at-grade transit network, including the modification or replacement of existing pavements or building new paved areas or roadways adjacent to the existing Barrie GO Line tracks. No tunnel construction along the preferred alignments has been planned.

A short-list of rapidway alternatives was identified and these run through the municipalities of (from south to north) Richmond Hill, Aurora and Newmarket/East Gwillimbury and are listed below.

- Richmond Hill (1 alternative) – RH2-Yonge Street;

- Aurora (3 alternatives) – A2-Yonge Street, A3-Yonge Street/Industrial Parkway/St. John's Sideroad, A4-Yonge Street/Industrial Parkway/adjacent to GO Barrie R-O-W;

- Newmarket/East Gwillimbury (6 alternatives) – NE2-Yonge Street/Green Lane, NE3-adjacent to GO Barrie R-O-W, NE5-Yonge Street/Eagle Street West/Newmarket GO Bus Terminal, NE6-Yonge Street/Davis Drive/Main Street/Green Lane, NE7-Yonge Street/Davis Drive to Leslie Street, NE8-Yonge Street/Davis Drive/Bayview Parkway/Green Lane.

For discussion purpose in the latter sections of this report, the proposed rapidway alternatives have been grouped into the following three main alignments:

- The first one extends along Yonge Street from 19th Ave (or Gamble Road) in Richmond Hill to Green Lane in Newmarket, for approximately 19.6 km, includes an alternative to Eagle Street West and ends at the Newmarket GO Bus Terminal;

- The other main alignment deviates from Yonge Street at Industrial Parkway in Aurora, continues north along the Barrie GO Line ROW and terminates at the Newmarket GO Bus Terminal at Green Lane, for approximately 12 km. There are several alternatives grouped under this alignment, and these include the deviations from the Barrie GO Line between Industrial Parkway and St. John's Sideroad, and again between Davis Drive and Green Lane. These alternatives are parallel to and are between 0.25 km and 0.5 km on the east or west sides of the Barrie GO Line;

- The third alignment extends along Davis Drive from Yonge Street to Leslie Street for approximately 4.2 km, and also includes other alternatives to connect Davis Drive and Green Lane by continuing the alignment on Main Street or Bayview Parkway.

2.0 SCOPE OF WORK

2.1 Information Resources

The review of subsurface conditions for the proposed rapidway route options was based on the following information:

- a visual reconnaissance of the route options;
- a review of geologic maps of the area prepared by the Ontario Geological Survey;
- the Ontario Ministry of Environment (MOE) Water Well Information System (WWIS);
- geologic mapping, including Quaternary Geology, Toronto and Surrounding Area, Southern Ontario, Preliminary map 2204, Ministry of Natural Resources, Ontario Geological Survey (1980);
- simplified geologic profiles obtained from Groundwater Monitoring of Oak Ridges Moraine Area by York-Peel-Durham-Toronto (YPDT) Groundwater Management Study, headed by the Conservation Authorities Moraine Coalition.

2.2 Evaluation Methods

The available information as listed above was examined with respect to the effects that the physical soil and groundwater conditions might have on the selection of route alternatives and potential future construction. Environmental conditions as related to the potential environmental quality of subsurface materials are discussed in a separate updated report prepared by Golder Associates ("North Yonge Street Corridor Public Transit and Associated Road Improvements Transit Class Environment Assessment, York Rapid Transit Project, Region of York, Ontario," dated May 2008).

The work conducted for and described within this report is intended to provide an overview of likely subsurface conditions and a preliminary summary of the possible effect that such subsurface conditions may have on the planned project with respect to route selection, and potential design and construction of pavements, track beds, and structural foundations. It is recommended and expected that additional work will be completed to refine the understanding of the subsurface conditions and their potential effects on design and construction once the route(s) is(are) selected. Such work should consist of borehole drilling and laboratory testing at selected locations determined as the project evolves.

The water well records shown on the cross-sections are contained in a modified and updated version of the Ontario Ministry of Environment (MOE) Water Well Information System (WWIS) database compiled as part of the York/Peel/Durham/Toronto (YPDT) study. The standard MOE subsurface material codes have been filtered through the Geological Survey of Canada's rule-based geomaterials coding system which is "...designed to take unaltered MOE water well tables and convert material codes to more geologically meaningful descriptions. The code assignments are based on rules developed for sediment found in the Greater Toronto Area (GTA) as part of the Oak Ridges Moraine National Mapping Program (NATMAP) study" (Logan & Russell, 2001).

The simplified subsurface profiles shown on Figures 6 to 12 were produced by the YPDT Study Team in the York Region, by mathematically interpolating the boundaries between several thousand interpreted stratigraphic unit data points from borehole and water well records across York Region.

The ground surface for the simplified geologic profiles developed by the computer modelling, as shown on Figures 6 to 12, does not match with the ground/road surface of the Yonge Street road profile or alternative route alignment for two primary reasons. Firstly, the ground surface mapping used to define the geologic database is based on borehole or well elevations and spot elevations and is not intended to accurately represent the ground surface elevation at any one particular location. Secondly, the profile along the centre line of Yonge Street or the alternative routes may be different than the surrounding ground as the result of localised cutting or filling activities carried out to achieve the road or railway grades in the area.

It is considered that the ground conditions in relation to the ground surface profile, as represented by this information, is sufficient for planning purposes at this stage of the project. Further work during preliminary design should address this issue in more detail with additional test borings, and more precise delineation of the differences in survey and database information, used to refine the interpretation of subsurface conditions along the proposed alignment(s).

3.0 SUBSURFACE CONDITIONS

3.1 Regional Geology

The Quaternary-age deposits of York Region consist predominantly of glacial till, glaciolacustrine sand, silt, and clay deposits, and shallow post-glacial lacustrine sediments. These deposits were laid down by glacial ice sheets and associated rivers and lakes. Recent deposits of alluvium are found in the river and stream valleys and their flood plains. Typically, bedrock is expected below a significant thickness of the sedimentary overburden (depths greater than 100 m).

The Quaternary soil deposits overlying the bedrock in the study area are believed to have been deposited over the course of two glaciations and one interglacial (i.e. warmer) stage. The oldest soil deposits identified in the Greater Toronto Area are the Illinoian tills which immediately overlie bedrock, where they are present. These tills are overlain by interglacial period lacustrine sands, silts, and clays that are, in turn, overlain by the most recent glacial deposits. Descriptions of the various deposits in relation to the study area are described below.

3.2 Local Subsurface Stratigraphy

A surficial geology map of the study area is shown on Figure 2. The simplified geologic cross-sections presented on Figures 6 through 12 illustrate the interpreted subsurface geology in the vicinity of Yonge Street within a zone of 200 m, between 19th Avenue and Green Lane in York Region. Note that the ground surface of the geologic cross-sections shown is only indicative of the top of selected boreholes/wells and should not be taken as the ground surface of the alignment.

The sections were extracted from a larger compilation of subsurface geology of the entire Oak Ridges Moraine and surrounding regions, including all of York Region. This larger regional compilation is part of the York-Peel-Durham-Toronto (YPDT) Groundwater Management Strategy Study, being conducted under the direction of Steve Holysh of the Conservation Authorities Moraine Coalition. The YPDT study partners provided the subsurface geologic information as a series of digital surfaces representing the upper boundaries of the various geologic units. The surfaces were provided with the understanding that they are preliminary draft versions, and will likely be modified before being finalised.

The stratigraphic units shown on Figures 6 through 12 generally correspond with a particular type of geologic material such as sand or fine-grained till. However, these units have been constructed as part of a regional study and significant heterogeneity is to be expected within each of the

geologic deposit types. The stratigraphic units are described below from oldest (and deepest) to youngest (and shallowest).

3.2.1 Paleozoic bedrock

The Paleozoic bedrock in the area consists primarily of the Georgian Bay Formation. This sedimentary rock formation includes shale, siltstone, sandstone and interbeds of limestone. Within the area of the planned project, it is expected that the bedrock will be at depths exceeding those necessary for foundations or excavations.

3.2.2 "Lower Drift"

The "Lower Drift" includes a series of deposits, interpreted by some as interbedded glacial tills and interglacial lacustrine (lake deposited) sediments, and by others as interbedded lacustrine delta sediments that include diamict. Diamict sediments are characterised by inclusions of angular coarse sand and gravel within finer-grained soils (either silt and sand or silt and clay), producing units that, overall, can be poorly graded. Glacial till, or sediments deposited at the contact between the overriding ice sheets and the underlying strata, are characteristically diamict units. Diamict can also be deposited in a near-ice lacustrine environment (with the coarse material "raining" into the sediments from the base of floating ice to the bottom of water bodies) rather than by glacial contact with the underlying sediments. This "Lower Drift" includes from oldest to youngest:

- **Don Formation:** the Don Formation, where present, consists primarily of layered silt and sand deposits that are in direct contact with the underlying bedrock formations;
- **Scarborough Formation:** the Scarborough Formation also consists primarily of layered silt and sand deposits overlying the Don Formation but these sediments were deposited at a later stage than the Don Formation;
- **Sunnybrook Formation:** the Sunnybrook Formation consists predominantly of fine-grained sediments that appear locally as layered diamict, massive diamict or layered fine-grained sediments more characteristic of lacustrine deposits. The composition and hard consistency of this material have resulted in this material being identified as a basal glacial till unit by some reference sources; and
- **Thorncliffe Formation:** the Thorncliffe Formation consists primarily of granular sediments including varying proportions of silt and sand.

3.2.3 Newmarket Till

The Newmarket Till is a regional glacial till sheet generally characterised by its predominantly fine-grained composition. In most areas this glacial till is relatively hard and, due to its fine-grained composition, forms a regional aquitard (deposit inhibiting flow of groundwater). The Newmarket Till also contains cobbles and boulders. In some areas, "boulder pavements" can be encountered where boulders are nested or concentrated in a layer within the till unit or near the interfaces with other geologic deposits. Experience on other construction projects in this deposit suggests that boulders may typically form about 0.1 to 0.5 per cent of the total deposit volume, though in some areas, boulders can form up to 2 per cent of the total deposit volume.

3.2.4 Oak Ridges Moraine Complex

The Oak Ridges Moraine Complex (ORMC) is a well-known and important geologic feature within the region. It is believed that the moraine was formed between the Lake Simcoe and Lake Ontario lobes of regionally extensive glacial ice sheets. In most areas, the ORMC is composed primarily of fine sand, though there are also local deposits of coarse, stratified sand and gravel. These coarse deposits have historically also been mined for construction uses and a number of former sand and gravel pits were located to the east of the alignment in the area between Yonge Street, Wilcox Lake, and Vandorf Sideroad, and Leslie Street. In most of the study area, the ORMC has been overridden by the Halton Till and, therefore, may be compact to very dense. Cobbles and boulders will also be present within this deposit.

3.2.5 Halton Till

The Halton Till is generally considered a fine-grained diamicton with minor fine-grained lacustrine sediments incorporated within the body of the unit, likely from glacial reworking of underlying lacustrine sediments. Throughout the study area, the Halton Till is draped over the underlying Oak Ridges Moraine Complex, generally following the former topography of the underlying deposit. In areas, however, the Halton Till is relatively thin, on the order of 5 to 10 m thick, where it has been eroded subsequent to its original deposition. The Halton Till is typically stiff to hard in consistency, though near the ground surface, weathering can result in the consistency being degraded to soft to firm. The Halton Till also contains cobbles and boulders. In some areas, "boulder pavements" can be encountered where boulders are nested or concentrated in a layer within the till unit. Experience on other construction projects in this deposit suggests that boulders may typically form about 0.1 to 0.5 per cent of the total deposit volume, though in some areas, boulders can form up to 2 per cent of the total deposit volume for large volumes of earth.

3.2.6 Upper Deposits

A number of potential materials are mapped on the interpreted stratigraphic sections as "Upper-Deposits". Based on local experience, these deposits generally include two types of materials: more recent natural post-glacial deposits, and deposits placed for construction or disposal of unwanted materials during development of the area.

- **Fill:** Fill generally consists of reworked native soil and/or rock materials, refuse, construction and demolition debris, and other assorted random materials placed during development of the area to level the ground in preparation for building or as a disposal site for unwanted materials. Typically, older fill materials were placed with little control over the materials or how they were placed.

- **Recent Alluvial Deposits:** In the areas of watercourses, erosion and redeposition of soil materials has occurred since the last glacial period. Geologically recent deposits from watercourses are typically soft or loose in consistency. Within the boundaries of the watercourse floodplains, the subsurface conditions can be expected to vary significantly as the alignment of the watercourse has likely shifted over time. The shifting positions of watercourses produces localised and in-filled meander channels and possible organic deposits (organic silt and clay or peat from the growth, burial, and decomposition of plant materials).

- **Recent Glaciolacustrine Deposits:** During the retreat of the last glacial ice sheet from the region, low areas in the surface topography became small water bodies (locally named the "Peel Ponds"). Sediments carried by surface water runoff and watercourses were deposited in these water bodies. In many areas, the sediments are characterized by alternating layers of soft to firm silt and clay resting on the underlying dense or hard glacial till, with overlying loose silt and sand deposits near the surface.

3.3 Regional Topography and Drainage

Topographic relief and drainage features within the study area are shown on Figure 3. The study area is located within the Oak Ridges Moraine Complex (ORMC) geomorphic region (Chapman and Putnam, 1984). The ORMC is a major depositional feature in this area forming a height of land (approximately 350 masl) along Bloomington Road. From the crest of the moraine, regional topography slopes towards the north (to Lake Simcoe) and south (to Lake Ontario).

The crest of the moraine is characterized by hummocky topography with kettle lakes (e.g. Philips Lake, Bond Lake, Thompson Lake) ponds, wetlands and dry depressions. The hummocky topography results in large number of small sub-catchments which drain internally. As a result, there are few permanent streams in the area of the moraine crest.

As shown on Figure 3, the headwaters of three principal watercourses of the region are located on the slopes of the ORMC within the study area. Headwater tributaries of the Holland River are located on the north slope of the ORMC. Tributary headwaters of the Humber and Rouge Rivers are located on the southern slope of the ORMC in the southwest and southeast sections of the study area respectively.

4.0 GROUNDWATER CONDITIONS

Groundwater conditions are expected to vary considerably along the various route alternatives. The groundwater discharge areas located within the vicinity of the study area are shown on Figure 4. Within the local route alignments, several water-bearing deposits may be encountered, depending on the final depth of construction. The water-bearing stratigraphic units are those that consist predominantly of granular soils (silt, sand, and gravel). These include:

- Recent Glaciolacustrine Deposits – where these deposits include granular soils; and
- Oak Ridges Moraine Complex

Of these deposits, the Oak Ridges Moraine Complex will be the primary groundwater aquifer (major water-bearing stratigraphic unit) influencing the design and construction of the project. Interpreted groundwater levels within the Oak Ridges Moraine Complex are shown on Figures 6 through 12.

It is expected that groundwater will be encountered generally within 10 m to 15 m below the ground surface, as illustrated on Figures 6 to 12, along the alignment, except at locations where there are water crossings. Because of the generally northward declining interfaces of the deposits north of Bloomington Road, groundwater within these sediments may have groundwater pressures in the low-lying areas that produce artesian conditions (where the groundwater will flow to the ground surface should the aquifer be punctured). This condition is particularly relevant where groundwater pressure levels and surface exposures of the Oak Ridges Moraine Complex coincide, creating the "discharge" conditions as indicated on Figure 4. This condition will also be relevant where incised drainage channels cut below the groundwater pressure elevation. In the northerly reach of the study area, in the vicinity of Davis Drive and Green Lane, the Oak Ridges Moraine Complex is at or near the ground surface and this aquifer appears to drain to the Holland River, thus reducing hydrostatic pressures consistent with the declines in topography. The potential magnitude of artesian pressures and the precise location where this conditions may be encountered cannot be further defined at this stage of the evaluation.

Although this unit will be the largest continuous aquifer, the presence of layers of low-permeability materials (silt and clay) between granular soils will produce areas of groundwater that are "perched" above the main aquifer. Each of the glacial till strata identified on the simplified geologic profiles will act as an aquitard and groundwater should be expected above the interfaces of any of these till units at the base of granular soils.

In all other areas, groundwater should be anticipated within 5 m of the ground surface for planning purposes, whether this groundwater represents “perched” or aquifer conditions. As groundwater levels will be highly controlled by the local subsurface stratigraphy, where groundwater conditions may be critical for planning, design, or construction, they should be investigated by means of observation wells or piezometers installed so as to differentiate between “perched” and aquifer groundwater levels.

5.0 GEOTECHNICAL EVALUATION FOR ENVIRONMENTAL ASSESSMENT

It is understood that the proposed transit route construction will consist primarily of modifying or replacing existing pavements or building newly paved areas or roadways adjacent to the existing Barrie GO Line tracks.

No tunnel construction along the preferred alignments has been planned.

5.1 Influence of Subsurface Conditions on Design and Construction

The Upper Deposits, as mapped on Figures 6 through 12 are likely to consist of one of the three ground conditions: Recent Alluvium, Recent Glaciolacustrine Deposits, or Fill.

Recent Alluvium may be encountered in the areas where the tributaries of the East Branch Holland River may have meandered and cut through several locations along the proposed alignments. The recent alluvium may consist of a variety of native materials. Subsurface conditions in this area should be well defined by staged investigations during the design process to determine the conditions that may govern local pavement designs. For planning purposes, the near-surface deposits (within the top two metres) of native soil will likely be soft to loose, depending upon composition. Early planning for pavement designs should be made on the basis of relatively poor subgrade conditions in the areas of water crossings. Foundations for structures will likely have to be designed to penetrate through these materials for desirable foundation performance; as this is for preliminary planning purposes, it should be assumed that bridge structures will require deep foundations.

Recent Glaciolacustrine Deposits, should they be encountered, are likely to be soft to firm silt and clay or loose to compact sand and silt. Early planning for pavement designs should be made on the basis of relatively poor subgrade conditions where these “Upper Deposits” are shown in this area. Foundations for structures will likely have to be designed to penetrate through these materials for desirable foundation performance.

Fill, placed for past urban development activities may be encountered throughout the preferred alignments. Along the Barrie GO line option, the Fill may also include railroad ballast and miscellaneous fill materials or debris. In general, the Fill should be considered to be uncontrolled in both material quality and placement processes, and therefore should be considered unsuitable for foundation support. Support of pavements on existing fill materials poses presently unquantifiable risks for subsequent performance.

It is also anticipated that the thickness and composition of fill materials will be random and the influence of existing Fill materials on the design and construction of the project should be examined in detail during subsequent phases of design. The presence or absence of extensive areas of Fill materials, placed during mass earthwork or demolition activities cannot be judged based on the available information at this time.

The Halton Till will likely be the primary native deposit encountered along all of the proposed routes, with the exception of the east to west sections that cross the valley of the Holland River. This deposit is relatively dense or hard and should be suitable for both foundation support and pavement subgrades. Although the overall consistency and composition of the deposit should not hinder pavement construction, in most areas it is anticipated that this deposit will be composed of fine-grained soils. The fine-grained nature of the soils will make moisture control during construction and long-term subgrade/sub-base drainage critical for long-term performance of pavements.

In some areas of the north to south alignment options, the Oak Ridges Moraine may immediately underlie the Upper Deposits between Industrial Parkway and North Lake Road, and near Jefferson Road and Stouffville Road the Halton Till may be relatively thin where it overlies the Oak Ridges Moraine Complex at this topographic high point. At the north end of the study area, in the area bound by Davis Drive and Green Lane, and Highway 404 and Yonge Street, the topography and geologic units near the ground surface have been altered by the broad valley of the Holland River. Where the ground surface is below approximately Elevation 270 m, the Oak Ridges Moraine Complex may be encountered at or near the ground surface beneath relatively thin veneers (on the order of 5 to 10 m thick) of either the Upper Deposits or the Halton Till. Recent Alluvium is expected in the vicinity of the Holland River. As noted above, the Upper Deposits (including the Recent Alluvium) may not be suitable for support of pavements or structures. The Oak Ridges Moraine Complex consists primarily of granular soil materials (silt, sand and gravel) that should generally be suitable for both foundation support and pavement subgrades except where local surface erosion, groundwater seepage points, or loose areas exist; it is anticipated that these areas should be readily managed within typical construction practices. Above approximately Elevation 270 m, toward Yonge Street and Highway 404, the Halton Till will be the predominant native soil unit that would be encountered along the east-west alignment options of Davis Drive and Green Lane.

5.2 Influence of Subsurface Conditions on Alignment Selection

The native subsurface conditions along the proposed alignments should be generally similar. Between two of the major alignment scenarios – generally along Yonge Street and nearby roadways (north to south or east to west roads) or along the Barrie GO rail line, the latter alignment following the rail line may be most influenced by filling and other earthwork activities

associated with CN railway construction. Materials used for filling and ballast beyond the existing track structures cannot be identified at this time and should be, for planning purposes, considered uncontrolled and unsuitable for support of either foundations or pavements. Native soil conditions, however, generally do not suggest one of the potential route options as more desirable than others from a geotechnical perspective.

The Oak Ridges Moraine Complex underlies the Halton Till in most locations, except at Industrial Parkway and most parts of the Green Lane and Davis Drive alternatives, where the Oak Ridges Moraine Complex underlies the Upper Deposits. These two alternative east-west routes are expected to exhibit similar geologic sections with respect to elevation, though the surface topography is somewhat different as elevations decrease toward the Holland River valley. Where the Oak Ridges Moraine Complex exists near the ground surface, the groundwater pressures in this deposit may have to be controlled to facilitate construction of the rapidway and associated structures depending on final design requirements. For most pavement and shelter foundation construction activities, groundwater control may be limited to control of surface runoff and minor seepage. It is understood at this time that the proposed rapidway construction will consist primarily of pavement construction/reconstruction, roadway widening, and new transit rider shelters at designated stops. If design progress suggests that deeper excavations may be required for other structures for which construction might be influenced by groundwater pressures within the Oak Ridges Moraine Complex, additional investigation and analysis will be required during design. Such groundwater lowering (or depressurization), if needed, may require either dewatering/depressurization systems or cut-off wall technologies to limit the influence of groundwater on both the construction and the effects of groundwater lowering, if any is necessary, on adjacent wells or properties. Additional exploration and engineering evaluation will be required to address issues associated with excavation and dewatering activities during final design and construction.

5.3 Recommendations for Future Explorations and Testing

The geotechnical evaluation presented in this report was prepared for the Environmental Assessment and overall evaluation of route options from a geotechnical perspective. This assessment has not identified significant differences among the potential route options with respect to the overall subsurface geology, except for the routes that follow within the existing railway corridor where human activities may have altered the condition of the near-surface materials (fill and altered native soils).

Based on the anticipated construction of new pavements, reconstruction of existing paved areas, and construction of new shelters, new subsurface investigations will likely be limited to characterization of the subsurface materials with respect to pavement support and bearing capacity for shallow spread footings or relatively small diameter (and depth) drilled shaft

foundations. Such explorations typically range in depth to between 1 to 5 m, as was completed for the existing VIVA rapid transit system structures. During design, additional exploration and testing will be required to identify geotechnical engineering parameters and hydrogeology with specific reference to the planned works. It is generally recommended that such investigation is carried out in phases as design progresses to further refine the subsurface characterization and recommendations for each particular situation. It is anticipated that three general phases of investigation may be required as follows:

Phase 1: examination of existing pavement designs and construction records for preliminary design of pavements and planning of subsurface investigations for detailed design;

Phase 2: subsurface investigations distributed relatively evenly throughout new pavement areas to define the general excavation and replacement requirements (for unsuitable fill and native materials), and test boreholes at each new shelter location to define subsurface conditions for foundation construction; and

Phase 3: additional explorations as needed to refine designs in areas indicated to exhibit greater variability in subsurface materials, where designs are particularly sensitive to the geotechnical engineering conditions, or additional information may be required to better plan construction or refine cost estimates.

All explorations should be designed to penetrate through existing fill materials into native soils. Based on the planned construction, it is not anticipated that boreholes exceeding 10 m depth or pumping tests would be needed.

6.0 LIMITATIONS AND USE OF REPORT

This report was prepared for the exclusive use of the Consortium and York Transit. Any use that a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of the third party. The report is based on data and information collected during the assessment of the North Yonge Street rapidway route options conducted by Golder. The report is based solely on the observations made at the time of a limited visual reconnaissance in September 2006, supplemented by a review of historical and publicly available information and data obtained by Golder as described in this report. No soil, water, liquid, gas, product or chemical sampling or analytical testing at or in the vicinity of the Site were conducted as part of this work. Evaluation of soil and groundwater environmental chemistry was not part of the scope of work undertaken for this report and must be addressed during subsequent phases of work for this project.

This report is intended to be used for planning purposes only, consistent with the feasibility and route selection activities underway at the time this report was prepared. Additional explorations of subsurface conditions will need to be carried out to better define the local geologic stratigraphy, groundwater levels, and the engineering properties of the subsurface materials for any further design activities.

7.0 CLOSURE

We trust this report provided the information required. However, should you have any questions, please do not hesitate to contact the undersigned.

Yours truly,

GOLDER ASSOCIATES LTD.

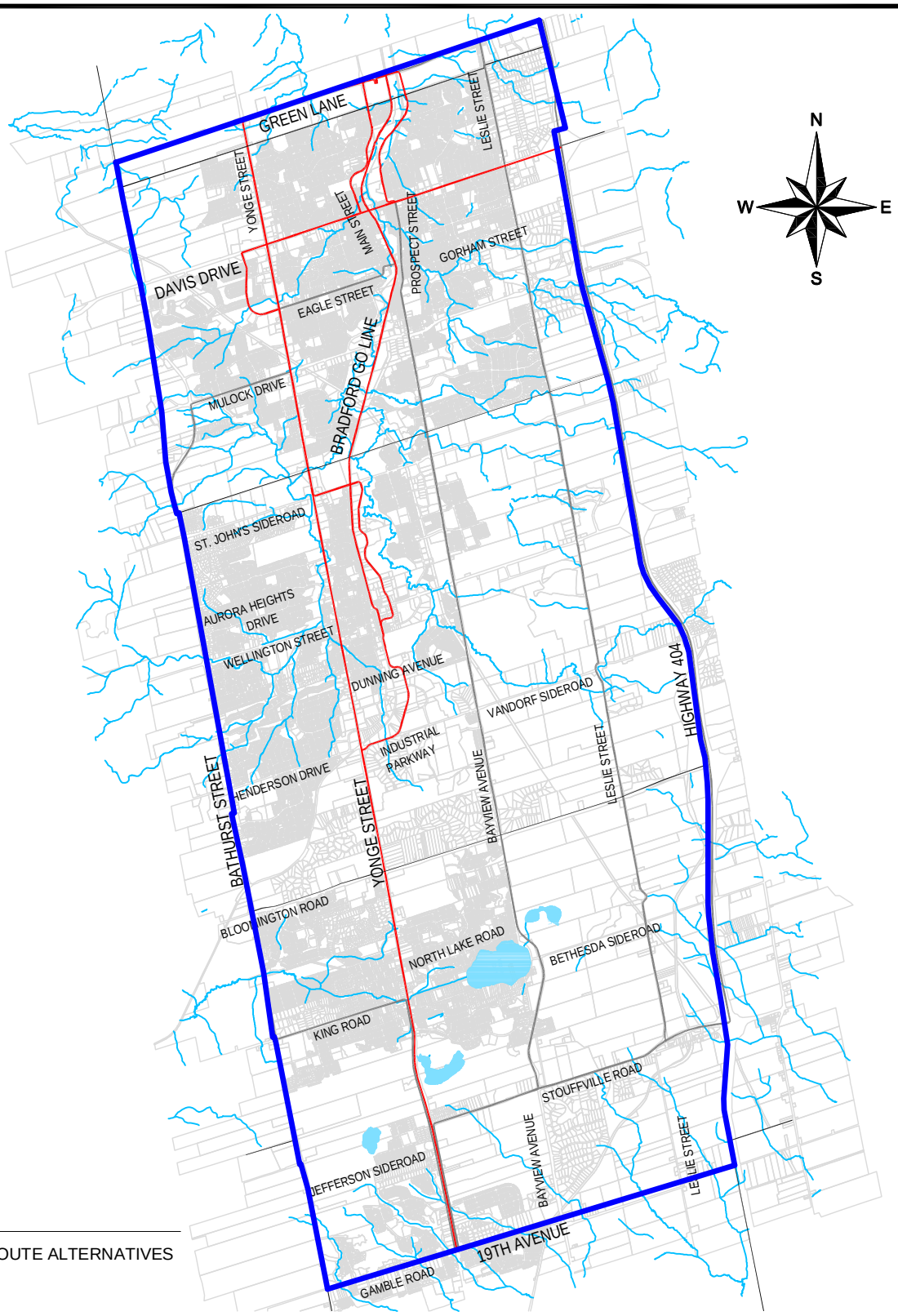
Beng Lay Teh
Geotechnical Group

Storer J. Boone, P.Eng., Ph.D.
Associate

John Westland, P. Eng.
Principal

BLT/SJB/JW/blt/sm

N:\ACTIVE\2006\1111\06-1111-039 YORK CONSORTIUM NORTH YONGE ST. EA YORK\REPORTS\EXISTING CONDITIONS-GEOTECH FINAL JULY 2008\06-1111-039 08JUL NORTH YONGE EA_GEOTECH.DOC



LEGEND:

PROPOSED ROUTE ALTERNATIVES

STUDY AREA

REFERENCES:

1. MAPPING BASED ON DRAWINGS FILES Alternative Routes.dwg; York Parcels 2005.dwg AND North Yonge EA Watercourses.dwg, PROVIDED BY YORK CONSORTIUM (DELCAN), RECEIVED SEPTEMBER 5, 2006.

2. PROJECTION IS UTM NAD83, ZONE 17.

2 0 2

SCALE 1:100000 KM

Golder Associates
Mississauga, Ontario, Canada

FILE No.	061111039AC001.dwg
PROJECT No.	06-1111-039
REV.	C
SCALE	AS SHOWN
DATE	July 24, 2008
DESIGN	BLT
CAD	MSM
CHECK	BLT
REVIEW	SJB

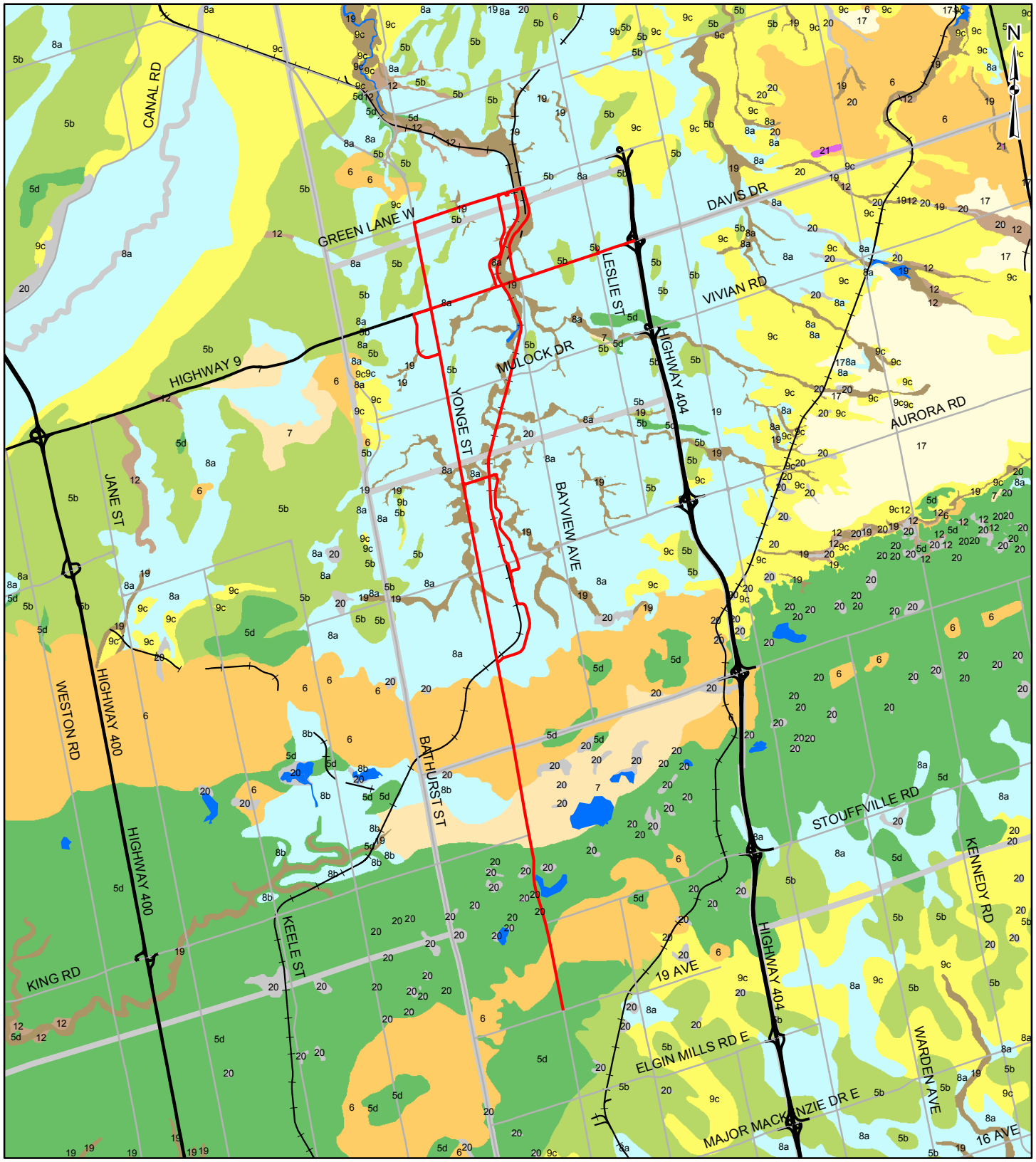
TITLE

STUDY AREA AND ROUTE ALTERNATIVES

NORTH YONGE STREET EA

FIGURE 1

PLOT DATE: July 24, 2008
FILENAME: T:\Projects\2006\06-1111-039 (York Consortium (DELCAN), Toronto)\-AC- (Phase 3000 Geotech)\061111039AC001.dwg



LEGEND

- Routes for Evaluation
- 5b: Stone-poor, carbonate-derived silty to sandy till
- 5d: Glaciolacustrine-derived silty to clayey till
- 6: Ice-contact stratified deposits
- 7: Glaciofluvial deposits
- 8a: Massive-well laminated
- 8b: Interbedded flow till, rainout deposits and silt and clay
- 9b: Littoral-foreshore deposits
- 9c: Foreshore-basinal deposits
- 12: Older alluvial deposits
- 17: Eolian deposits
- 19: Modern alluvial deposits
- 20: Organic deposits
- 21: Man-made deposits
- Waterbody

REFERENCE

Datum: NAD 83 Projection: UTM Zone 17N; Base Data - MNR NRVIS, obtained 2004, CANMAP 2005.4, OGS 2003
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2006

0 1 2 4 6 8
Kilometres

PROJECT
NORTH YONGE STREET EA

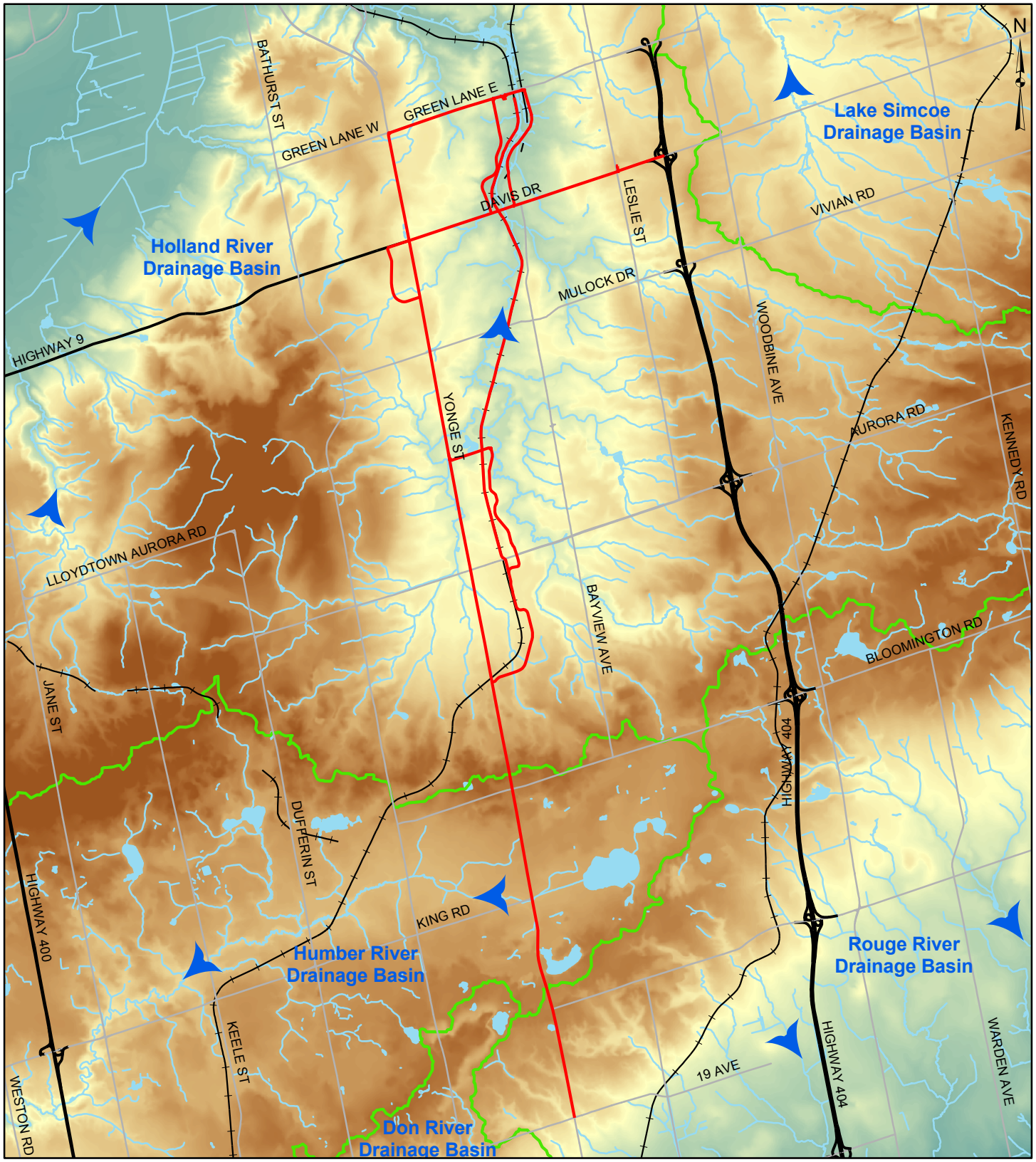
TITLE
SITE LOCATION AND SURFICIAL GEOLOGY MAP

Golder Associates
Mississauga, Ontario

PROJECT No. 06-1111-039			SCALE 1:125,000	REV. 1
DESIGN	PRM	04 Oct. 2006		
GIS	PRM	18 Jul. 2008		
CHECK	BLT	18 Jul. 2008		
REVIEW	SJB	18 Jul. 2008		

FIGURE: 2

G:\Projects\2006\06-1111-039_North_Yonge_EA\GIS\MXDs\Draft\Surficial_Geology.mxd



LEGEND

- Flow Direction
- Routes for Evaluation
- Watercourse
- Waterbody
- Watershed Boundary

Elevation (masl)
370.0
165.0

REFERENCE

Datum: NAD 83 Projection: UTM Zone 17N; Base Data - MNR NRVIS, obtained 2004, CANMAP 2005.4
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2006

PROJECT

NORTH YONGE STREET EA

TITLE

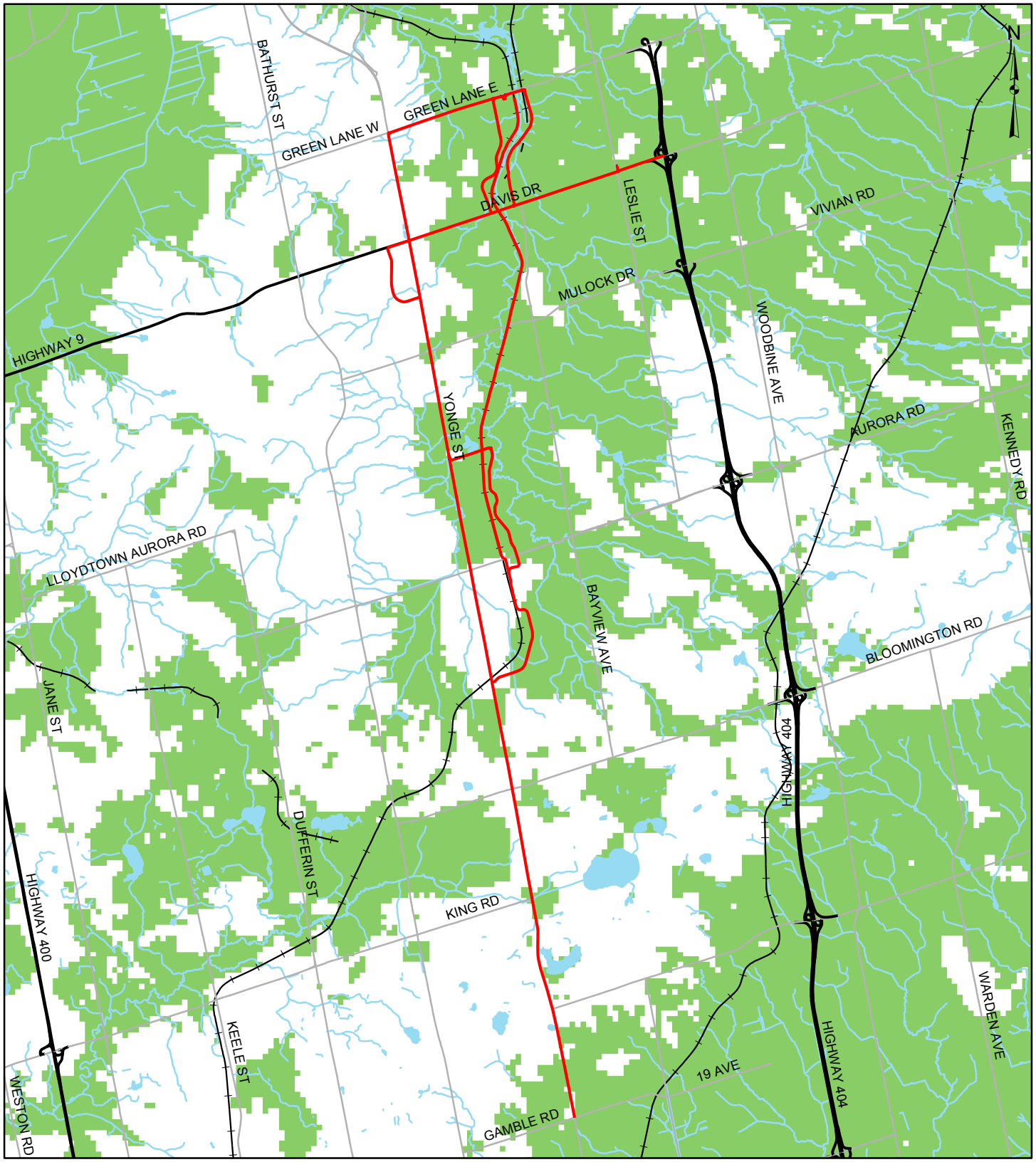
TOPOGRAPHIC RELIEF AND REGIONAL SURFACE WATER FLOW

Golder Associates
Mississauga, Ontario

PROJECT No. 06-1111-039			SCALE 1:100,000	REV. 0
DESIGN	PRM	04 Oct. 2006		
GIS	BC	18 Jul. 2008		
CHECK	SMD	18 Jul. 2008		
REVIEW	SJB	18 Jul. 2008		

FIGURE: 3

G:\Projects\2006\06-1111-039_North_Yonge_EA\GIS\MXDs\Draft\Topographic_Relief.mxd



LEGEND

- Routes for Evaluation
- Groundwater Discharge Area

REFERENCE

Datum: NAD 83 Projection: UTM Zone 17N; Base Data - MNR NRVIS, obtained 2004, CANMAP 2005.4, Groundwater Discharge Areas from York Region (Sept. 2004)
Produced by Golder Associates Ltd under licence from Ontario Ministry of Natural Resources, © Queens Printer 2006

PROJECT

NORTH YONGE STREET EA

TITLE

GROUNDWATER DISCHARGE AREAS

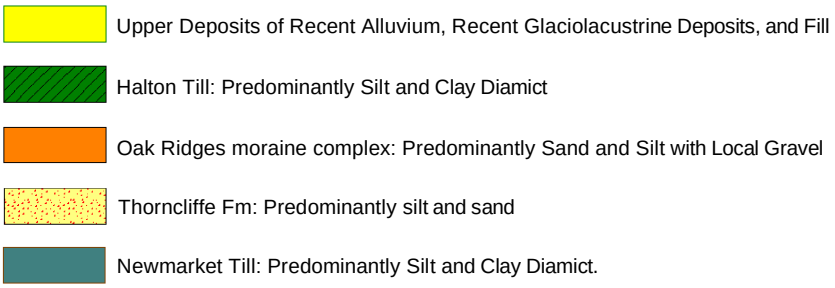
Golder Associates
Mississauga, Ontario

PROJECT No. 06-1111-039			SCALE 1:100,040	REV. 0
DESIGN	PRM	04 Oct. 2006		
GIS	PRM	10 Nov. 2006		
CHECK	BLT	10 Nov. 2006		
REVIEW	SJB	10 Nov. 2006		

FIGURE: 4

G:\Projects\2006\06-1111-039_North_Yonge_EA\GIS\MXDs\Draft\GW_Discharge_Areas_generalized.mxd

GEOLOGIC STRATIGRAPHIC LEGEND:



NOTES:

1. DRAWINGS INDICATE A SIMPLIFIED INTERPRETATION OF GEOLOGIC DEPOSIT TYPES BASED ON WIDELY-SPACED BOREHOLE INFORMATION THAT WAS PREPARED BY OTHERS. THE SUBSURFACE CONDITIONS ARE TO BE CONSIDERED ONLY PRELIMINARY INDICATIONS OF SUBSURFACE MATERIALS AND SHOULD NOT BE USED FOR DESIGN PURPOSES WITHOUT CONFIRMATION OF ACTUAL CONDITIONS USING FIELD EXPLORATIONS.
2. THIS DRAWING MUST BE READ WITH THE ACCOMPANYING TEXT.
3. GROUND SURFACE PROFILE AND PLAN DATA PROVIDED BY DELCAN CORP.

REFERENCES:

1. SIMPLIFIED GEOLOGIC PROFILE AS PROVIDED BY REGION OF YORK (YPDT WATER MANAGEMENT).
2. INTERPRETED WATER LEVEL PROFILE BASED ON WATER LEVEL DATA PROVIDED BY YORK REGION, SEPTEMBER, 2004

Golder Associates
Mississauga, Ontario, Canada

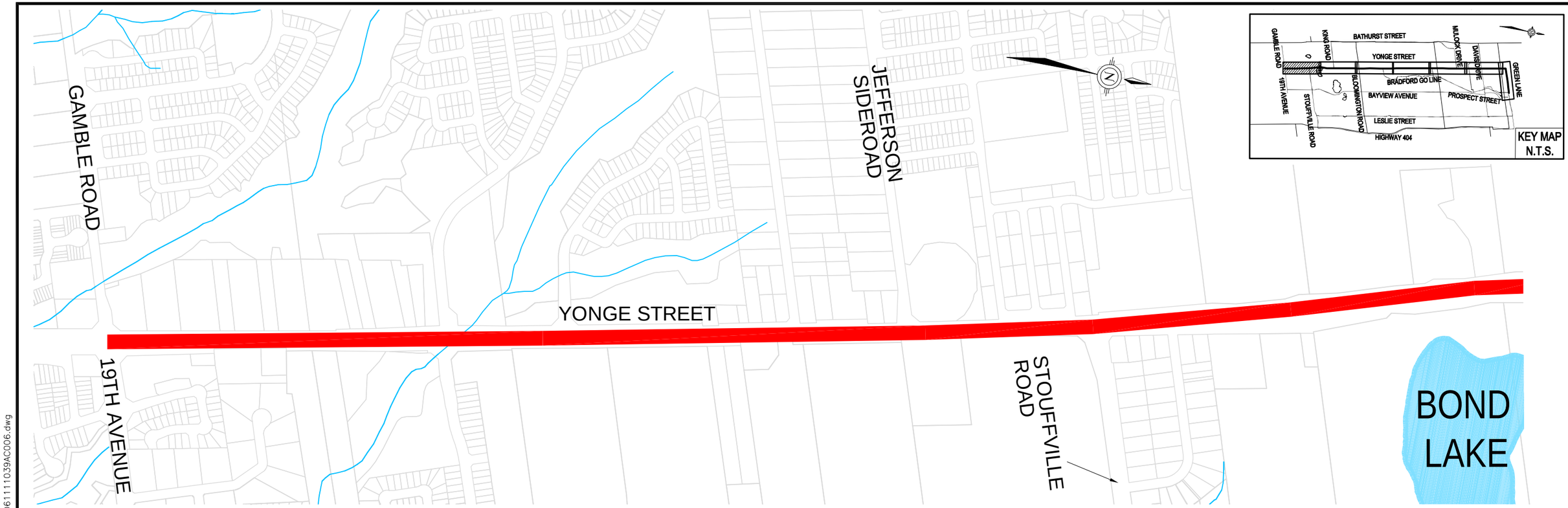
FILE No.	061111039AC005.dwg
PROJECT No.	06-1111-039
REV.	C
SCALE	N.T.S.
DATE	July 21, 2008
DESIGN	BLT
CAD	MSM
CHECK	BLT
REVIEW	SJB

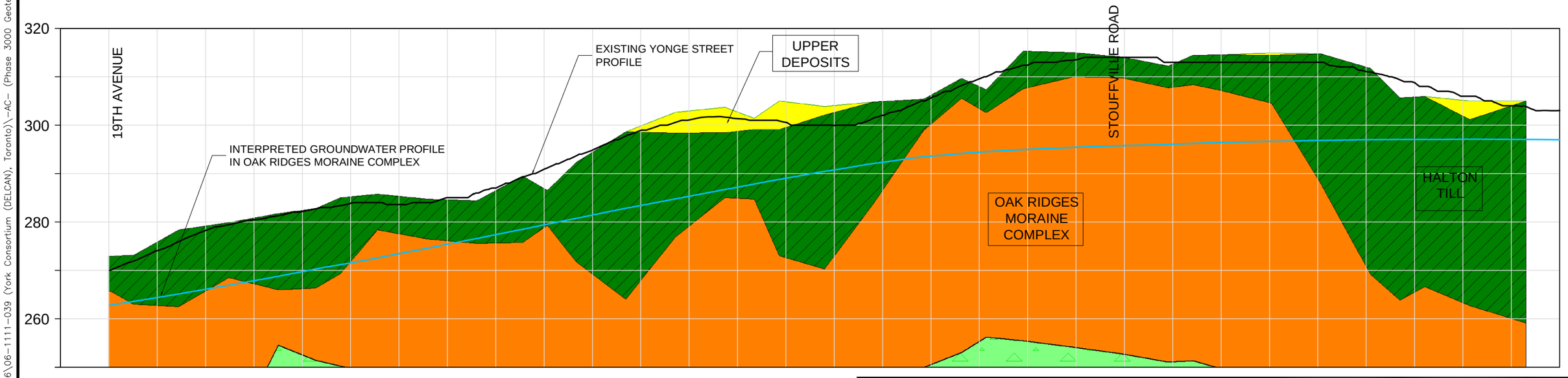
TITLE
LEGEND TO SIMPLIFIED GEOLOGIC PROFILES

NORTH YONGE STREET EA

FIGURE 5

PLOT DATE: July 23, 2008
FILENAME: T:\Projects\2006\06-1111-039 (York Consortium (DELCAN), Toronto)\-AC- (Phase 3000 Geotech)\061111039AC005.dwg





NOTES:

1. REFER TO FIGURE 5 FOR GEOLOGIC DEPOSIT LEGEND.
2. VERTICAL EXAGGERATION IS 10 TIMES.

160 0 160 320
SCALE HORIZONTAL 1:8000 METRES

16 0 16 32
SCALE VERTICAL 1:800 METRES

Golder Associates
Mississauga, Ontario, Canada

FILE No.	061111039AC006.dwg
PROJECT No.	06-1111-039
REV.	C
SCALE	AS SHOWN
DATE	July 23, 2008
DESIGN	BLT
CAD	MSM
CHECK	BLT
REVIEW	SJB

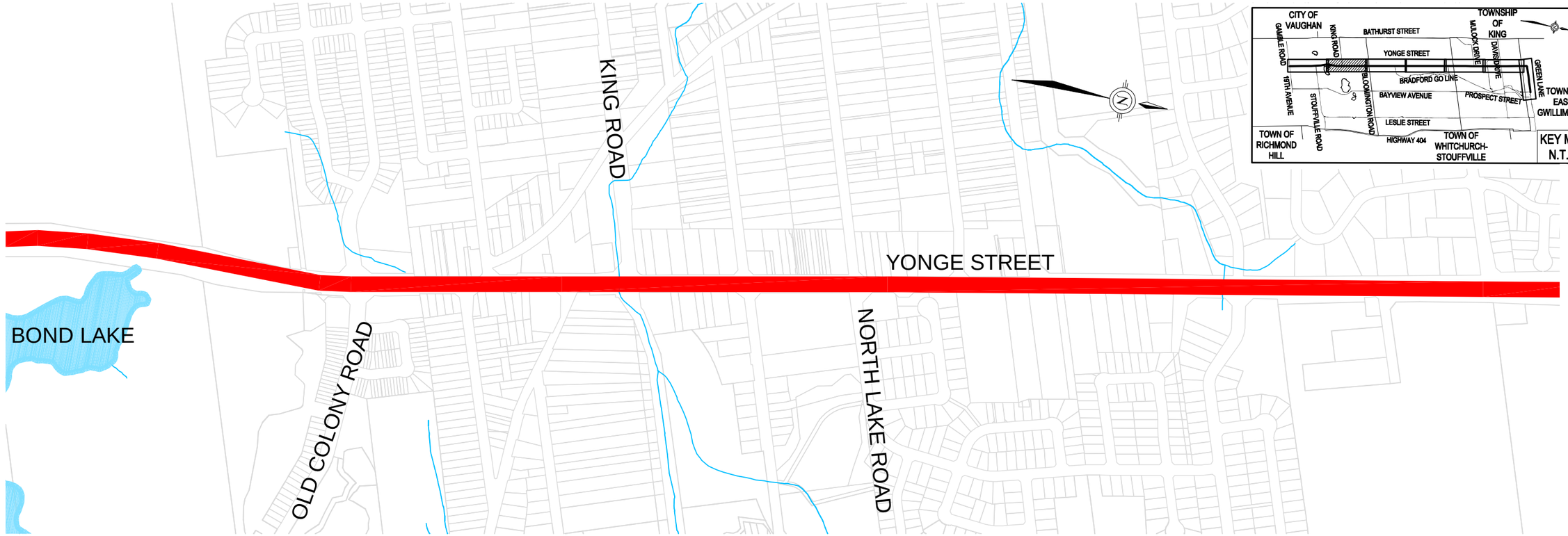
TITLE

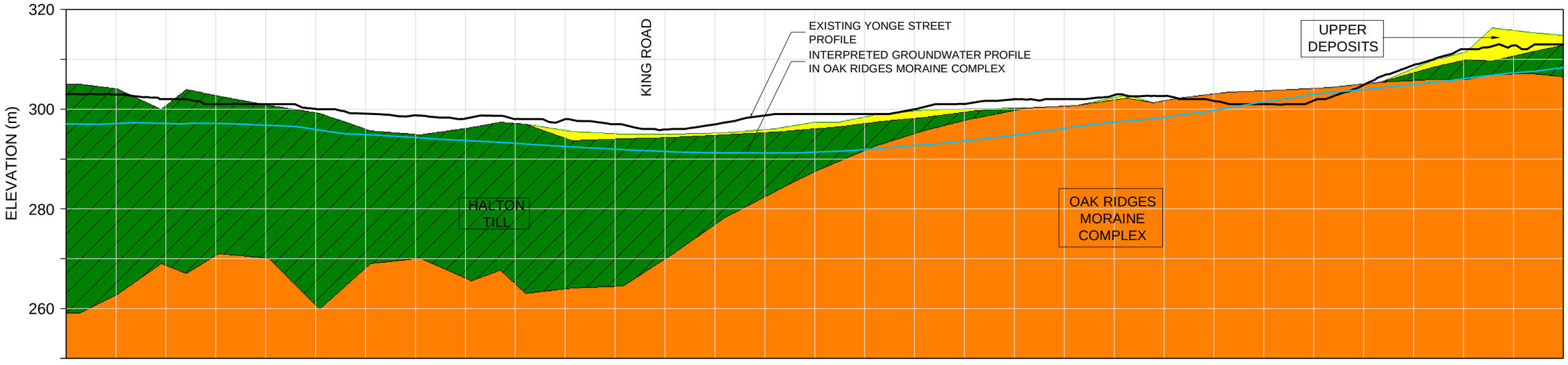
PLAN AND SIMPLIFIED GEOLOGIC PROFILE

NORTH YONGE STREET EA

FIGURE 6

PLOT DATE: July 23, 2008
FILENAME: T:\Projects\2006\06-1111-039 (York Consortium (DELCAN), Toronto)\-AC- (Phase 3000 Geotech)\061111039AC006.dwg





NOTES:

1. REFER TO FIGURE 5 FOR GEOLOGIC DEPOSIT LEGEND.

2. VERTICAL EXAGGERATION IS 10 TIMES.

160 0 160 320
SCALE HORIZONTAL 1:8000 METRES

16 0 16 32
SCALE VERTICAL 1:800 METRES

Golder Associates
Mississauga, Ontario, Canada

FILE No.	061111039AC007.dwg
PROJECT No.	06-1111-039
REV.	C
SCALE	AS SHOWN
DATE	July 23, 2008
DESIGN	BLT
CAD	MSM
CHECK	BLT
REVIEW	SJB

TITLE

PLAN AND SIMPLIFIED GEOLOGIC PROFILE

NORTH YONGE STREET EA

FIGURE 7

PLOT DATE: July 23, 2008
FILENAME: T:\Projects\2006\06-1111-039 (York Consortium (DELCAN), Toronto)\-AC- (Phase 3000 Geotech)\061111039AC007.dwg

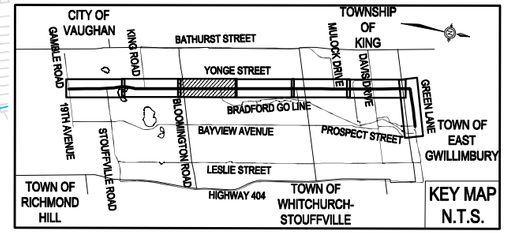
TOWN OF RICHMOND HILL

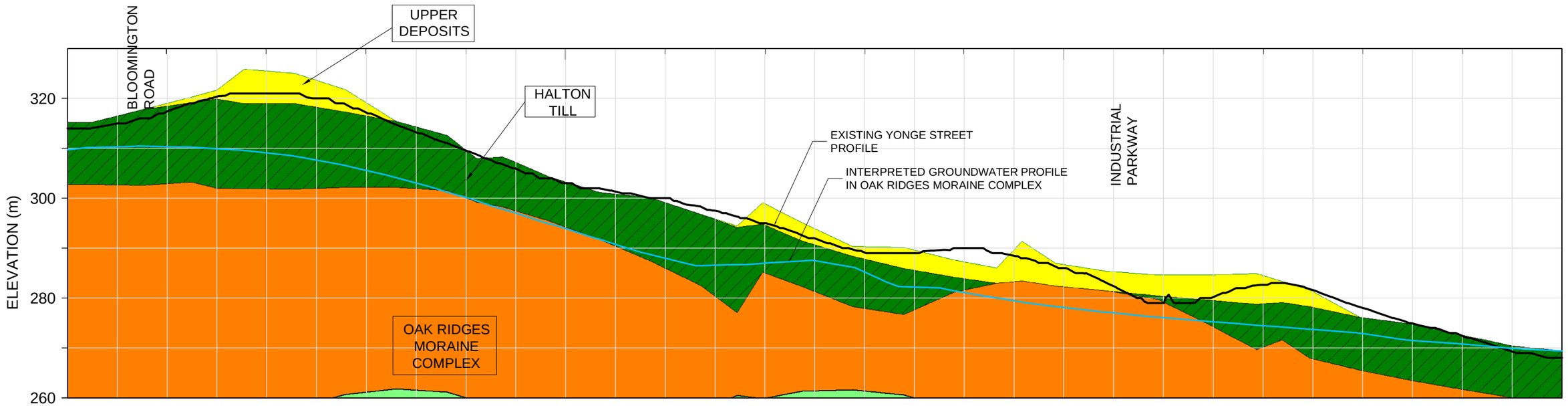
TOWN OF AURORA

BLOOMINGTON ROAD

YONGE STREET

INDUSTRIAL PARKWAY





NOTES:

1. REFER TO FIGURE 5 FOR GEOLOGIC DEPOSIT LEGEND.
2. VERTICAL EXAGGERATION IS 10 TIMES.

160 0 160 320
SCALE HORIZONTAL 1:8000 METRES

16 0 16 32
SCALE VERTICAL 1:800 METRES

Golder Associates
Mississauga, Ontario, Canada

FILE No.	061111039AC008.dwg
PROJECT No.	06-1111-039
REV.	C
SCALE	AS SHOWN
DATE	July 23, 2008
DESIGN	BLT
CAD	MSM
CHECK	BLT
REVIEW	SJB

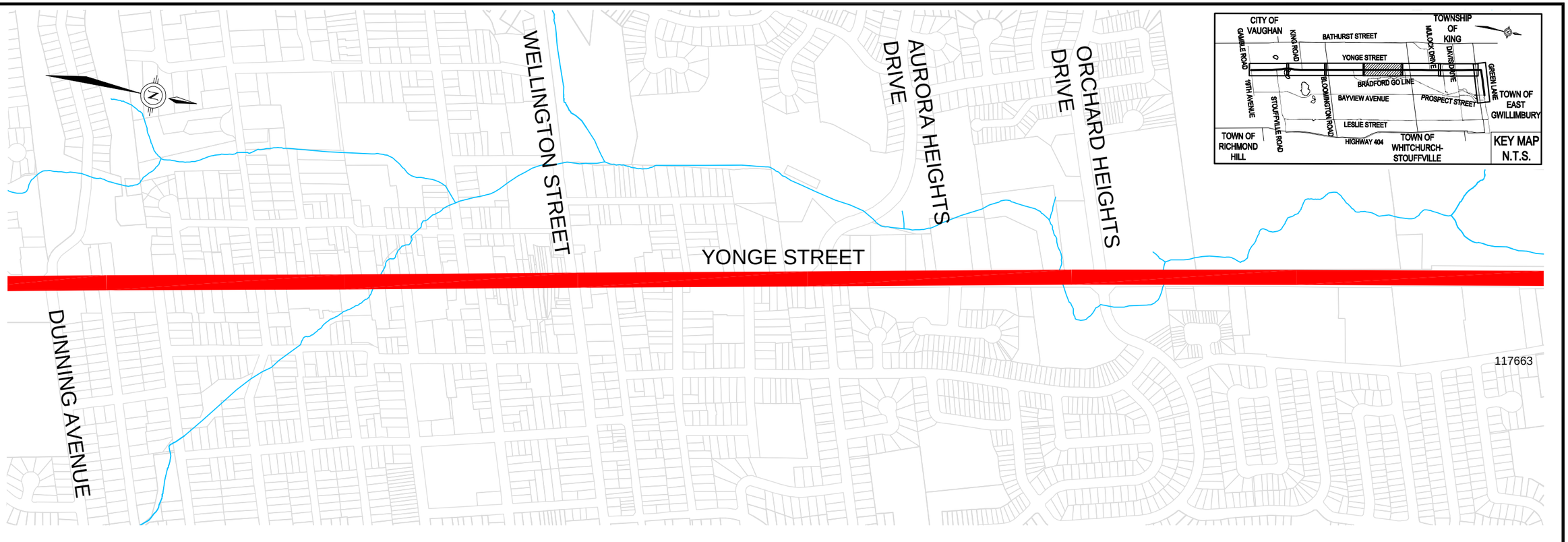
TITLE

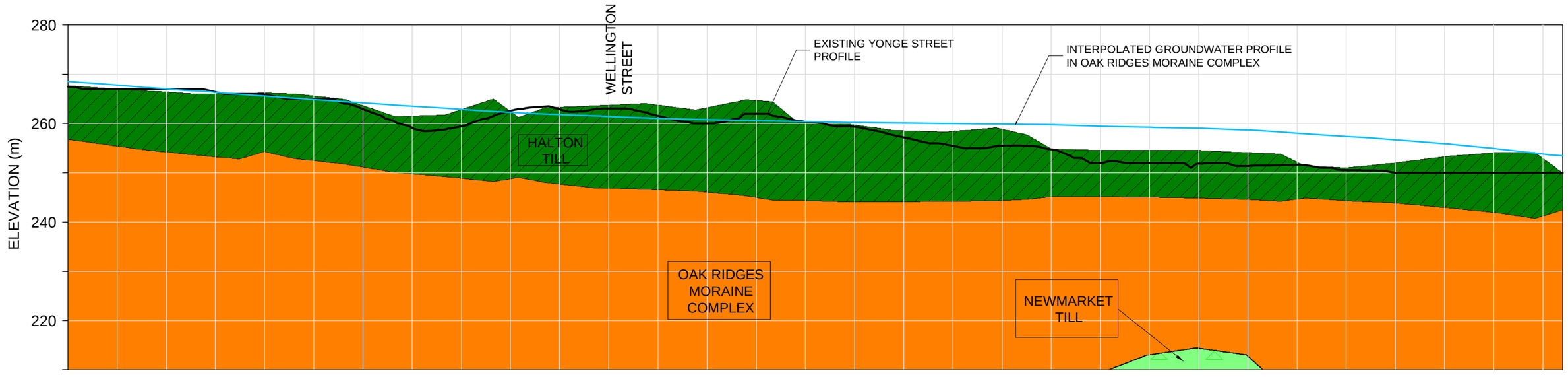
PLAN AND SIMPLIFIED GEOLOGIC PROFILE

NORTH YONGE STREET EA

FIGURE 8

PLOT DATE: July 23, 2008
FILENAME: T:\Projects\2006\06-1111-039 (York Consortium (DELCAN), Toronto)\-AC- (Phase 3000 Geotech)\061111039AC008.dwg





NOTES:

1. REFER TO FIGURE 5 FOR GEOLOGIC DEPOSIT LEGEND.

2. VERTICAL EXAGGERATION IS 10 TIMES.

160 0 160 320
SCALE HORIZONTAL 1:8000 METRES

16 0 16 32
SCALE VERTICAL 1:800 METRES

Golder Associates
Mississauga, Ontario, Canada

FILE No.	061111039AC009.dwg
PROJECT No.	06-1111-039
REV.	C
SCALE	AS SHOWN
DATE	July 23, 2008
DESIGN	BLT
CAD	MSM
CHECK	BLT
REVIEW	SJB

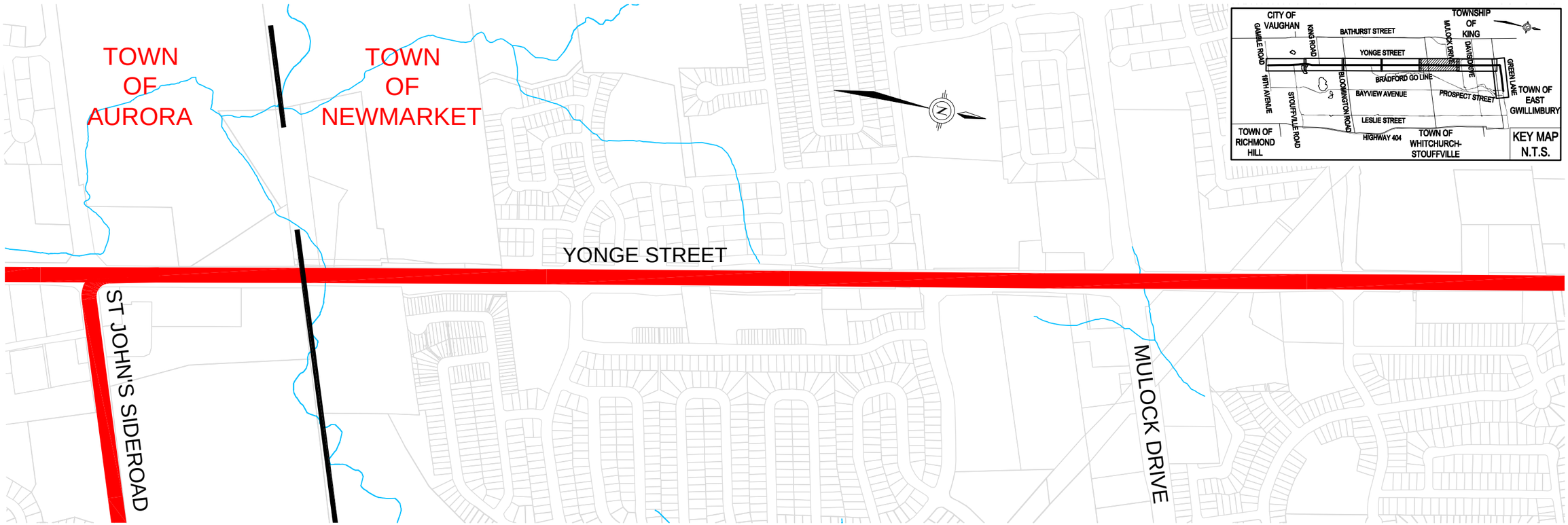
TITLE

PLAN AND SIMPLIFIED GEOLOGIC PROFILE

NORTH YONGE STREET EA

FIGURE 9

PLOT DATE: July 23, 2008
FILENAME: T:\Projects\2006\06-1111-039 (York Consortium (DELCAN), Toronto)\-AC- (Phase 3000 Geotech)\061111039AC009.dwg



NOTES:

1. REFER TO FIGURE 5 FOR GEOLOGIC DEPOSIT LEGEND.
2. VERTICAL EXAGGERATION IS 10 TIMES.

160 0 160 320
SCALE HORIZONTAL 1:8000 METRES

16 0 16 32
SCALE VERTICAL 1:800 METRES

Golder Associates
Mississauga, Ontario, Canada

FILE No.	061111039AC010.dwg
PROJECT No.	06-1111-039
REV.	C
SCALE	AS SHOWN
DATE	July 23, 2008
DESIGN	BLT
CAD	MSM
CHECK	BLT
REVIEW	SJB

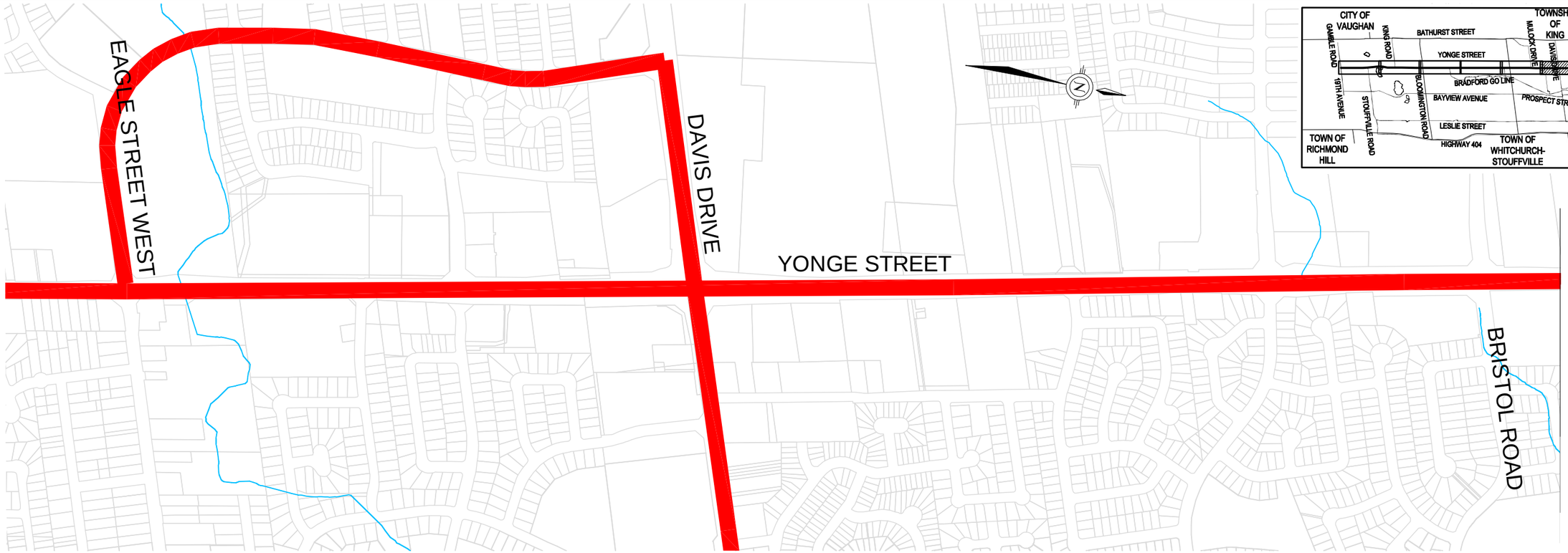
TITLE

PLAN AND SIMPLIFIED GEOLOGIC PROFILE

NORTH YONGE STREET EA

FIGURE 10

PLOT DATE: July 23, 2008
FILENAME: T:\Projects\2006\06-1111-039 (York Consortium (DELCAN), Toronto)\-AC- (Phase 3000 Geotech)\061111039AC010.dwg



NOTES:

1. REFER TO FIGURE 5 FOR GEOLOGIC DEPOSIT LEGEND.

2. VERTICAL EXAGGERATION IS 10 TIMES.

160 0 160 320
SCALE HORIZONTAL 1:8000 METRES

16 0 16 32
SCALE VERTICAL 1:800 METRES

Golder Associates
Mississauga, Ontario, Canada

FILE No.	061111039AC011.dwg
PROJECT No.	06-1111-039
REV.	C
SCALE	AS SHOWN
DATE	July 23, 2008
DESIGN	BLT
CAD	MSM
CHECK	BLT
REVIEW	SJB

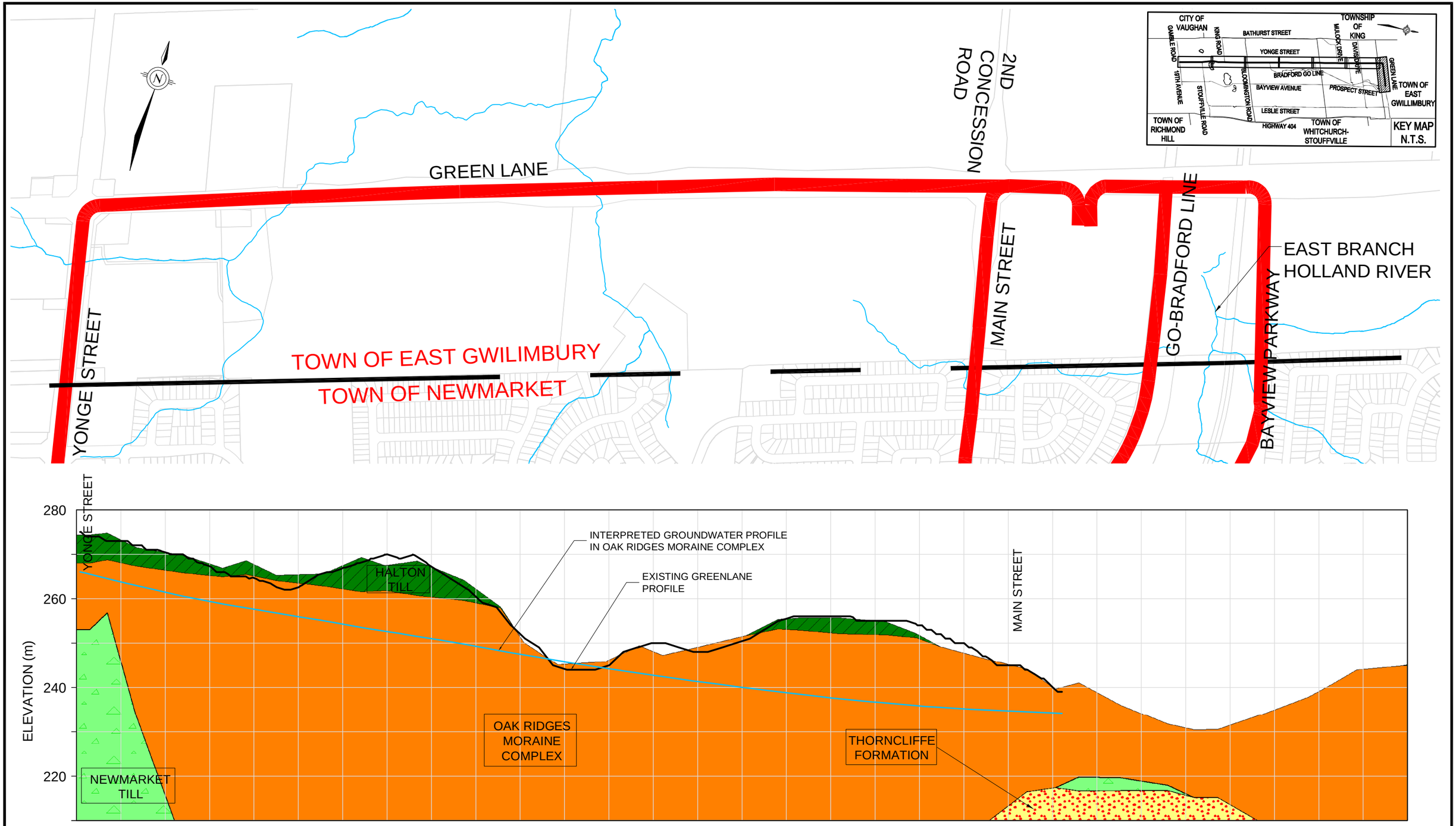
TITLE

PLAN AND SIMPLIFIED GEOLOGIC PROFILE

NORTH YONGE STREET EA

FIGURE 11

PLOT DATE: July 23, 2008
FILENAME: T:\Projects\2006\06-1111-039 (York Consortium (DELCAN), Toronto)\-AC- (Phase 3000 Geotech)\061111039AC011.dwg



NOTES:

1. REFER TO FIGURE 5 FOR GEOLOGIC DEPOSIT LEGEND.
2. VERTICAL EXAGGERATION IS 10 TIMES.

160 0 160 320
SCALE HORIZONTAL 1:8000 METRES

16 0 16 32
SCALE VERTICAL 1:800 METRES

Golder Associates
Mississauga, Ontario, Canada

FILE No.	061111039AC012.dwg
PROJECT No.	06-1111-039
REV.	C
SCALE	AS SHOWN
DATE	July 23, 2008
DESIGN	BLT
CAD	MSM
CHECK	BLT
REVIEW	SJB

TITLE

PLAN AND SIMPLIFIED GEOLOGIC PROFILE

NORTH YONGE EA

FIGURE 12

PLOT DATE: July 23, 2008
FILENAME: T:\Projects\2006\06-1111-039 (York Consortium (DELCAN), Toronto)\-AC- (Phase 3000 Geotech)\061111039AC012.dwg